



'Adaptive (Feedback) Environmental Monitoring for the Management of Dredging and Reclamation Activities'

Panama – May 2018

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Origins of Feedback EMMP (Monitor, Evaluate and Adapt!)

Singaporean / Malaysian Port Developments

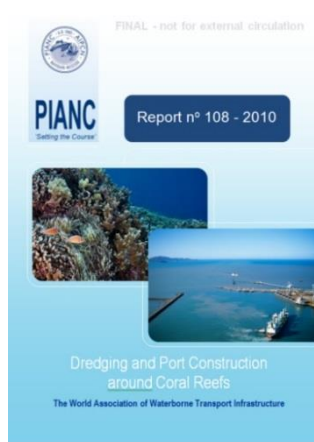


Images

<http://www.seanews.com.tr/malaysia-s-port-of-tanjung-pelepas-sets-aside-funds-for-more-cranes-in-2016/157017/>
<http://ifonlysingaporeans.blogspot.com/2015/06/pasir-panjang-terminals-35b-expansion.html>
<https://archerrecruitment.com/news/we-are-not-done-building-singapore-yet-lawrence-wong>
<https://sgx.i3investor.com/blogs/singaporestockmarketnews/16764.jsp>

EMMP Credentials

- Approach endorsed / recognized by
 - WODCON XVIII (2007) (Best Practice)
 - UNEP, and
 - IFC's Environmental, Health, and Safety Guidelines for Ports, Harbors, and Terminals www.ifc.org/ehsguidelines



Applied in:

- Denmark
- Sweden
- Germany
- Indonesia
- Singapore
- Malaysia
- Brunei
- Australia
- New Zealand
- ...

Assessing Environmental Objectives (**Opportunities**/Impacts)



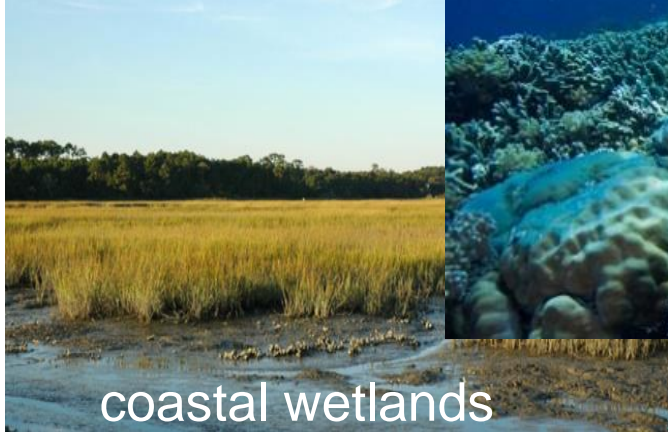
seaweeds

corals



coastal wetlands

seagrasses



coastal wetlands

Assessing Environmental Objectives (Opportunities/Impacts)

The project can cause socio-economic changes such as:

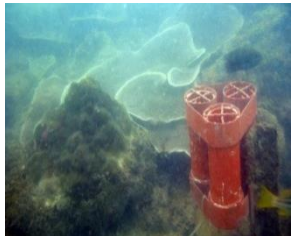
- general deviations from project objectives
- change in natural fisheries and aquaculture operations
- loss of operational efficiency and higher operational maintenance cost to powerplants and process water installations
- increased maintenance costs for port and harbours due to incremental sedimentation in channels and at berths
- impacts to recreational experiences and facilities, i.e. with corresponding economic losses to hotels and marinas, due to aesthetic changes in water quality, and in some rare cases...
- impacts to international relations arising from sediment plume / sedimentation intrusion across international borders.



Traditional Environmental Monitoring and Management Plans (EMMPs)



- A traditional monitoring management program would typically include:
 - Static (i.e. fixed location) monitoring of turbidity
 - Typically at receptors predicted to be impacted according to the EIA
 - Static (i.e. fixed location) monitoring of habitats
 - Typically at receptors predicted to be impacted according to the EIA
 - Periodic Monitoring of water quality
 - Typically close to the work area / prescribed distance from activities
- Typical management criteria would be worded like:
 - *Concentration 200m from the dredger shall not exceed 100mg/l*
 - *Reduction in live coral cover / eelgrass biomass shall not exceed 5%*



Traditional EMMPs: Why They Don't Work

- In general, the traditional approach tends to falter because it fails to recognize a number of key pieces of the puzzle, e.g.:
 - the importance between background vs. incremental spatial variability induced by the project
 - the linkage between operations and impact – or change in operation and mitigation
 - response lag-times associated with habitat monitoring
 - The tools and 'language' needed to communicate with the Contractor generating the 'sources'
 - Inability to differentiate between sources within a work area or between one work area and another



Feedback EMMPs

a 'Feedback EMMP':

- Speaks the language of a contractor
- Recognizes the spatial and temporal variability of works (e.g. sediment plumes and sedimentation)
- Isolates source contributions e.g. TSS / Sedimentation
- applies specific objectives for the project
- Addresses response lag-times
- Allows for a transparent (incl. stakeholders) proactive management process
- Provides comprehensive accounting of temporal achievements/impacts



Feedback EMMP Includes All Pieces of the Puzzle

Traditional “Reactive” EMMP

Fixed receptor monitoring stations
(Physical and biological parameters)

+

Trigger Limits

+

Respond when Trigger is Exceeded

Proactive “Feedback” EMMP

All the features of Traditional EMMP

+

Spill Budget

+

Hindcast Modelling / Dedicated
Trigger Limits

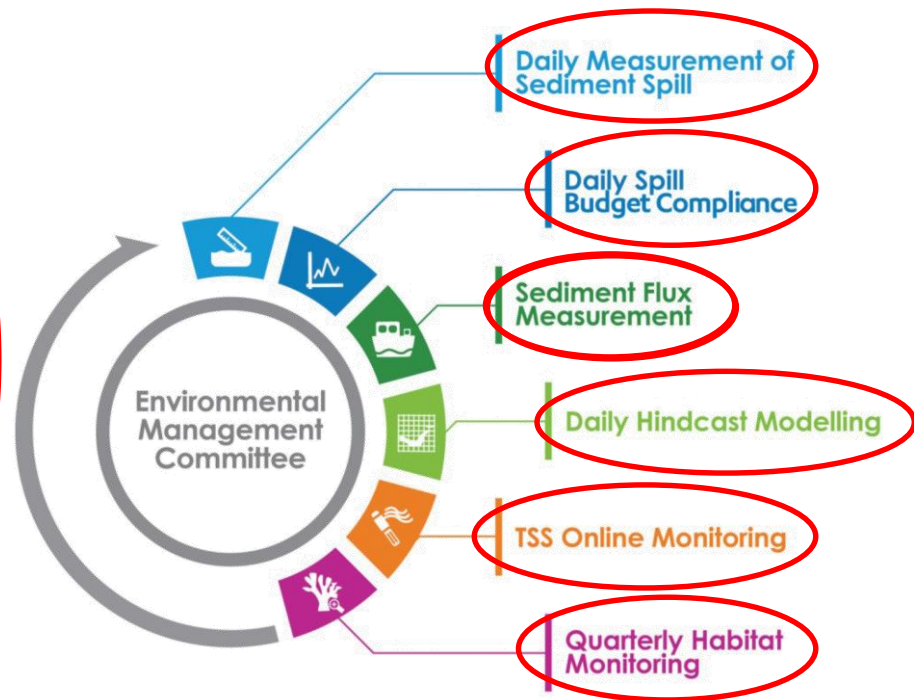
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Feedback

(Updating of spill control limits based on receptor
monitoring)

Feedback EMMP: A Tiered Approach for Dredging Works

- Provides 4 feedback tiers of Control
 1. Spill Budget Compliance
 2. Trigger / Tolerance limit (EQOs) Compliance
 3. Real time Monitoring to provide, validate or correct compliance analyses
 4. Habitat Monitoring to provide feedback on tolerance limits
- The tiers reinforce each other...



Feedback EMMP: Stages

Before Start of Dredging / Reclamation (understand the environment):

- Deploy and calibrate Control **Monitoring** Instrumentation
- Establish **baseline** (3-12 months)
- **Identify win-win opportunities**/receptors (key species) for monitoring/Establish tolerance / alert limits and EQOs
- Calibrate & validate **numerical models**
- Assess impact of work plan (update of EIA) and determine **draft spill budget** based on contractors actual plan and equipment
- If non-compliant **update overall work plan** and finalize spill budget for start of works



During Dredging / Reclamation (Control):

- Daily spill **monitoring** and control against spill budget
- Daily **hindcast modelling** to document spatial extent of realized spill and control against EQO's at each receptor
- Realtime / periodic control monitoring (alert limits)
- Identify **mitigating actions**, if required
- Review and **update spill** budget



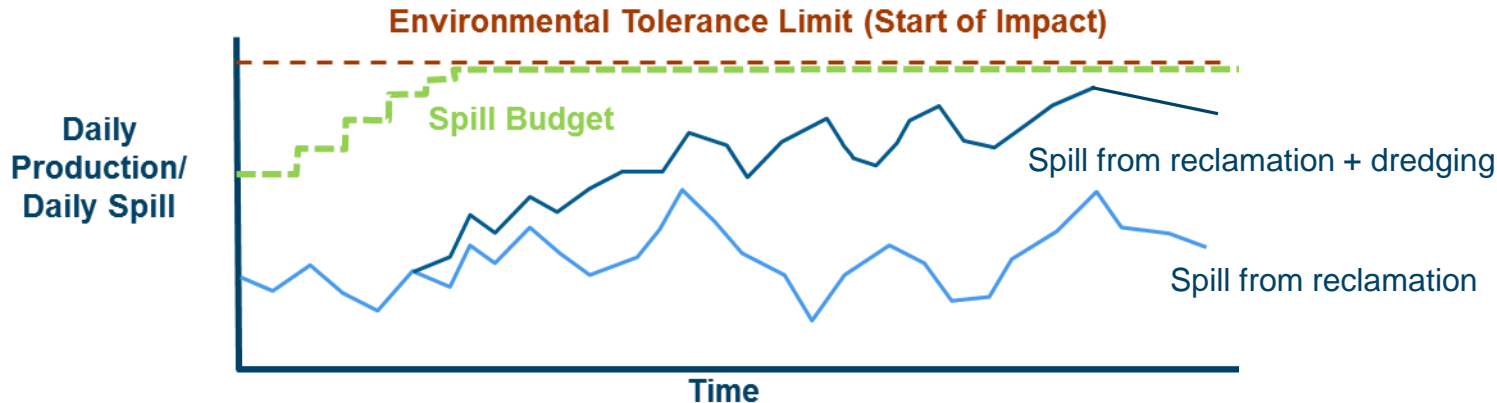
After Completion of Dredging / Reclamation:

- Control monitoring continues for 3 – 6 month post-construction period
- Environmental Audit prepared to compare impacts to EIA

Feedback EMMP: Before the Start of Dredging / Reclamation

Spill = Portion of (fine) sediments that are released or mobilized at source from dredge or reclamation activities

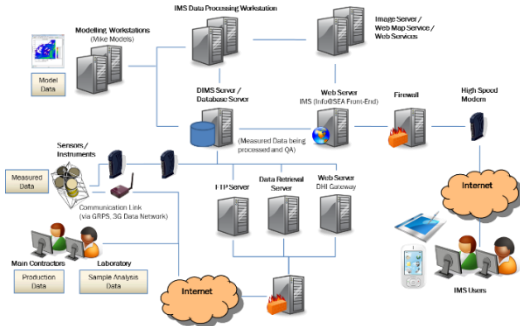
Spill Budget = Maximum amount of sediment spill (fine sediments) that can be released in the waters but still meet the EQOs for the project



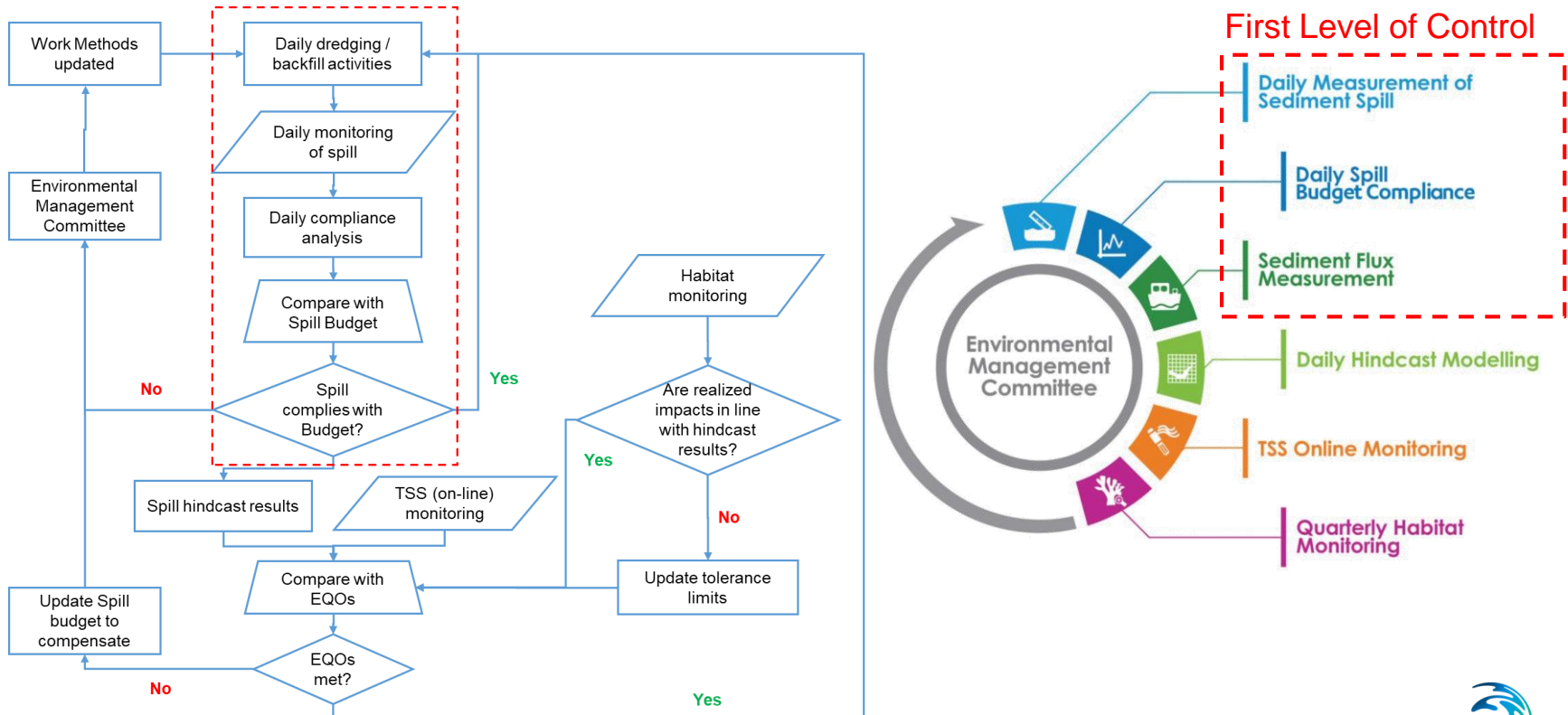
Feedback EMMP: Before the Start of Dredging / Reclamation



- Feedback EMMP mobilization also typically includes:
 - Review of Project Objectives/EIA findings and confirmation of appropriate Environmental Quality Objectives and Tolerance Limits
 - Establish an Environmental Management Committee (EMC)
 - Set-up of an EMMP document / data management system / portal
 - effectiveness depends on rapid access to information for all stakeholders throughout the EMMP
 - Engagement with dredge contractor / Client, authorities and stakeholders

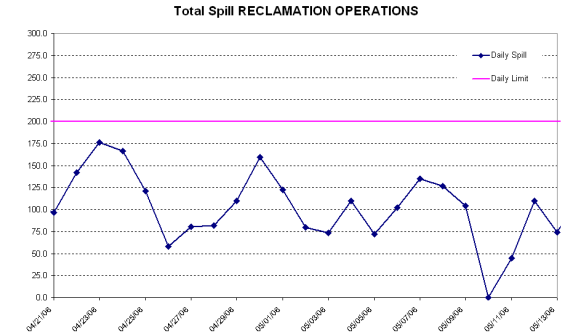
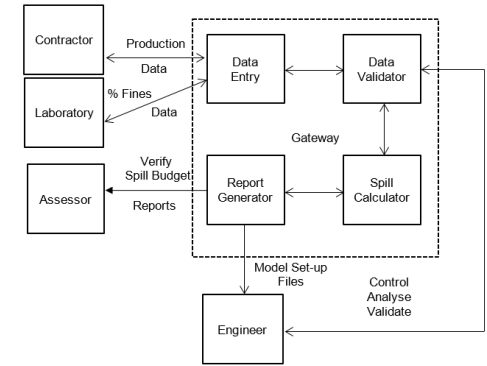


Feedback EMMP: First Level of Control - Spill Budget

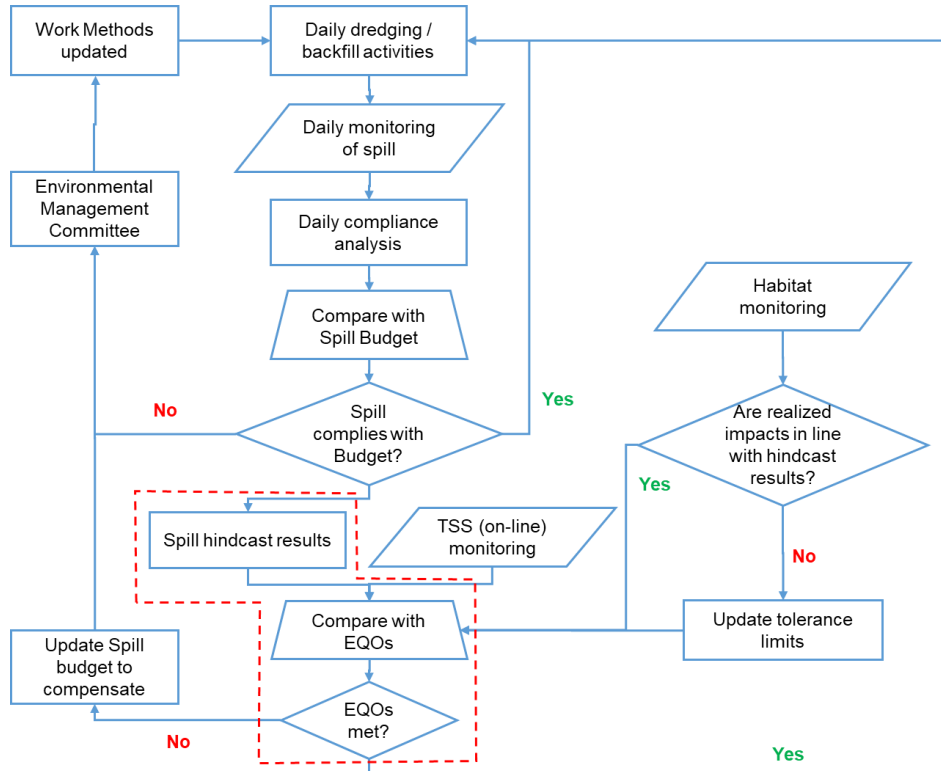


Feedback EMMP: Spill Budget Compliance

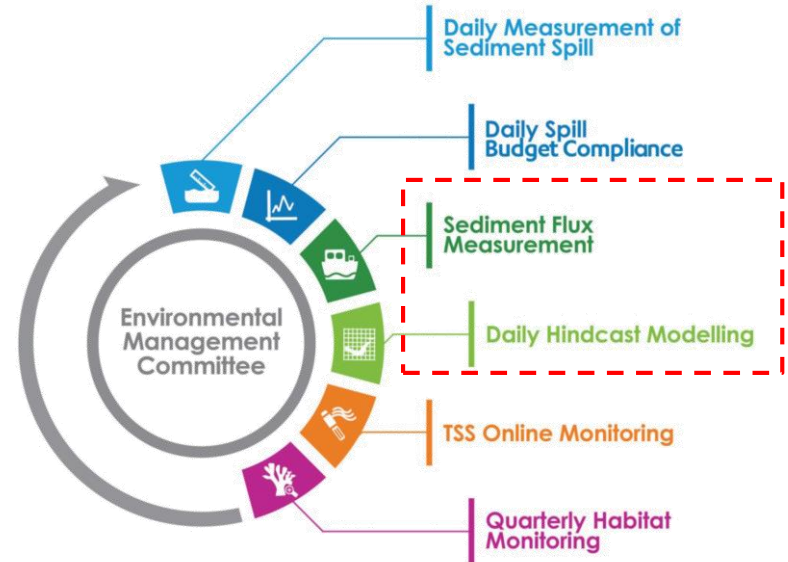
- Daily sediment samples and work activity information is collected from the dredge contractor
 - This information undergoes / is used:
 - laboratory analyzes
 - to calculate actual daily sediment spill
- These results are used to determine Spill Budget compliance and generate a daily compliance report
- Input also used for hindcast TSS and sedimentation modelling (2nd Tier)



Feedback EMMP: Second Level of Control - Plume Hindcast



Second Level of Control



Feedback EMMP: Second Level of Control - Plume Hindcast

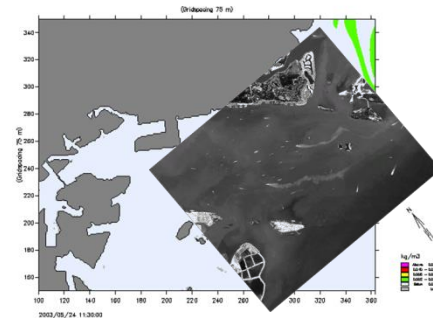
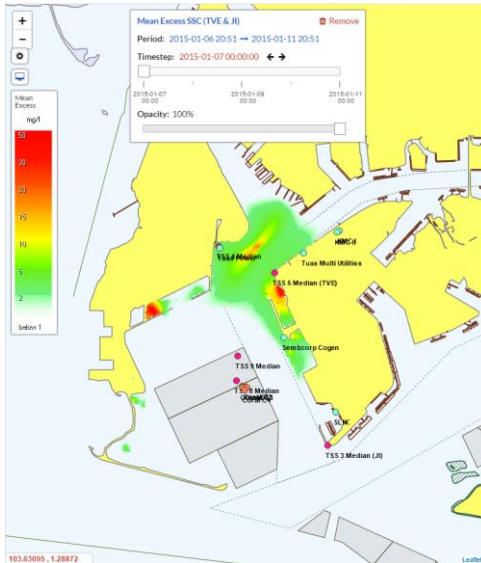
InfoSEA
Measurement Spill Hindcast Spill Control

TSS Median

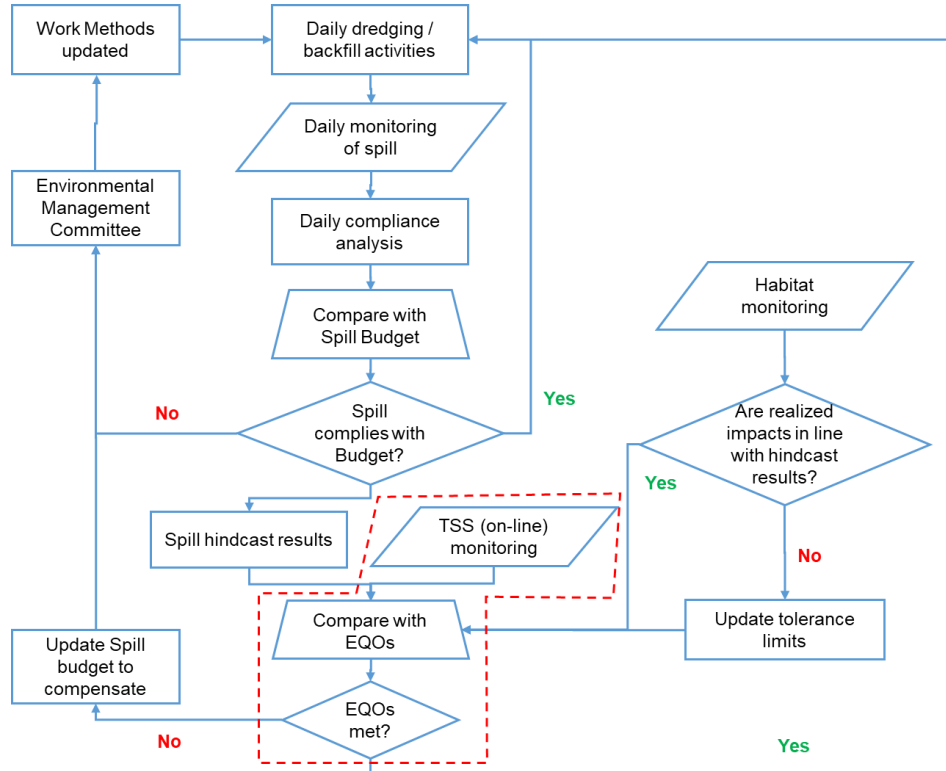
Sensor	Latest	10 Min (mg/l)		3 Hr (mg/l)		3 Hr (mg/l)		1 Day (mg/l)		3 Day (mg/l)		7 Day (mg/l)		14 Day (mg/l)	
		Med	Lim	Med	Lim	Med	Lim	Med	Lim	Med	Lim	Med	Lim	Med	Lim
TSS 4 Median	11-Jan 20:35	4.61	15.76	4.61	12.6	4.67	9.45	4.44	7.09	4.84	6.3	4.63	5.51	4.31	4.73
TSS 8 Median	11-Jan 20:30	3.45	8.67	3.73	6.93	3.45	5.2	1.78	3.9	1.99	3.47	1.985	3.03	2.08	2.6
TSS 9 Median	11-Jan 20:35	4.56	6.67	4.755	5.33	4.86	4	3.92	3	4.13	2.67	4.15	2.33	4.05	2
TSS 3 Median (LI)	11-Jan 18:35	2.535	32.42	2.86	25.94	2.86	19.45	4.28	14.59	4.8	12.97	4.41	11.35	4.02	9.73
TSS 5 Median (TVE)	11-Jan 20:30	7.06	26.22	7.01	20.98	6.91	15.73	4.87	11.8	6.63	10.49	4.57	9.18	4.32	7.87

Hindcast modelling is a critical component for the Feedback EMMP

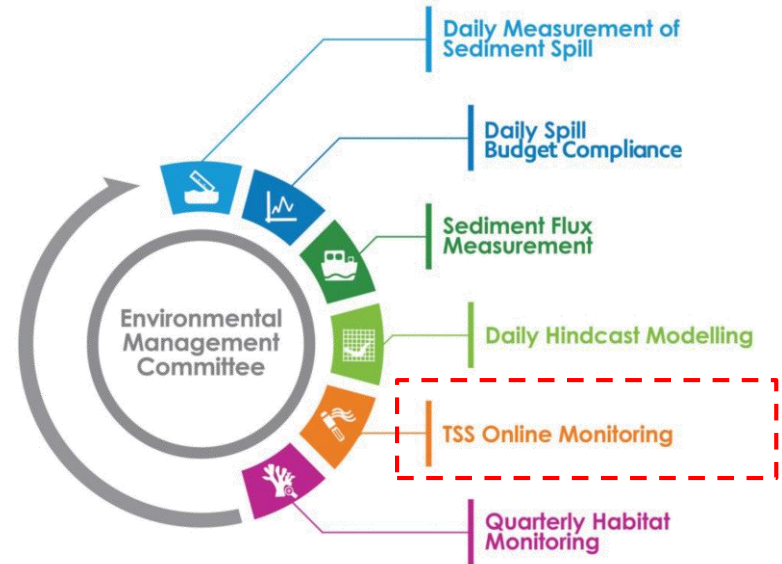
- The measured spill of fine sediments from every dredging trip is simulated using the numerical model
- The model results are compared against the receptor locations and site specific tolerance limits on a daily basis
- This highlights potential impacts to any of the receptors before they occur, allowing proactive management measures



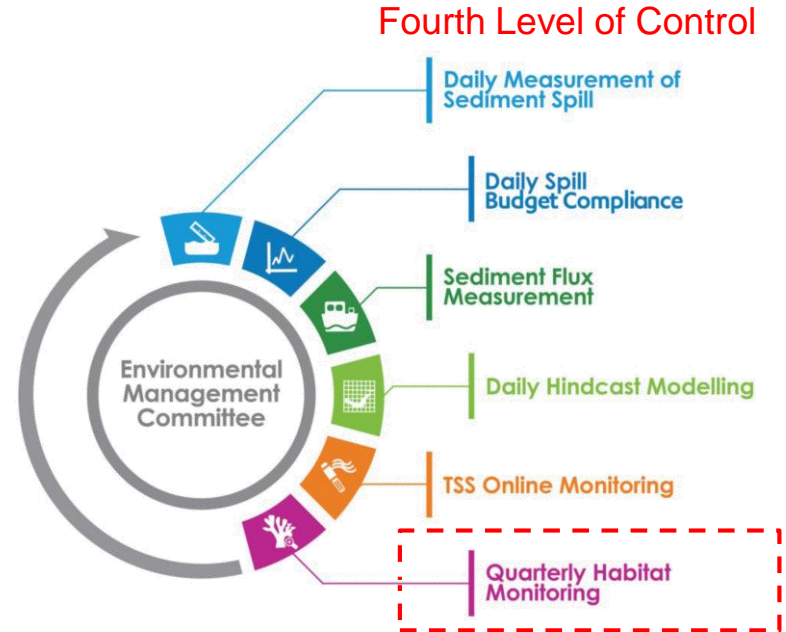
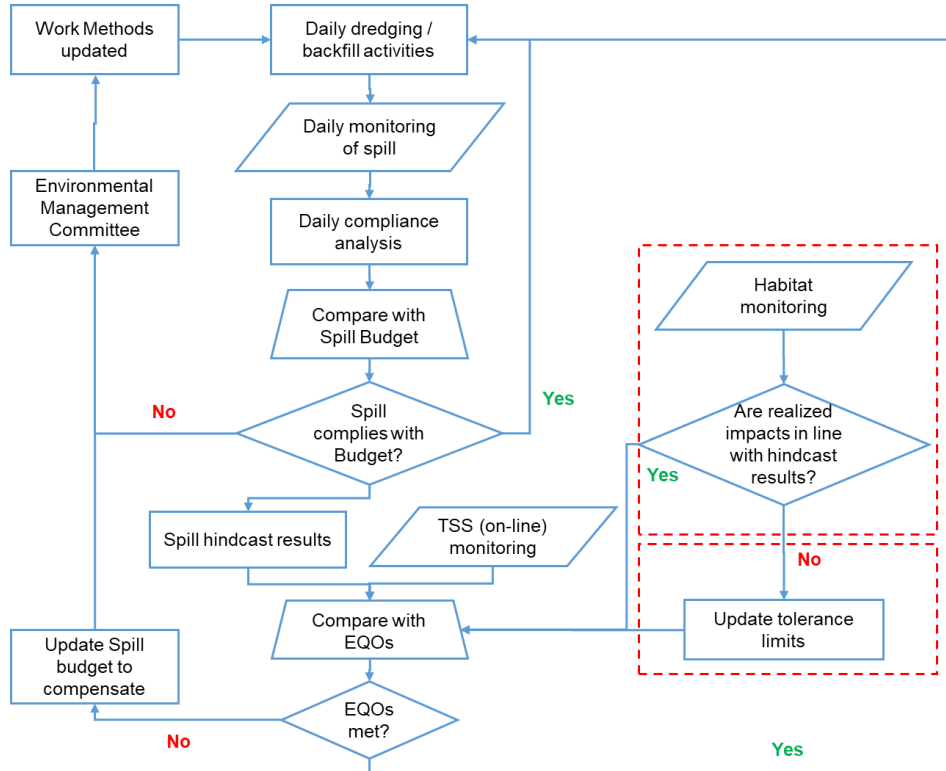
Feedback EMMP: Third Level of Control - Real Time Monitoring



Third Level of Control



Feedback EMMP: Update Tolerance Limits and Spill Budget



Feedback EMMP: Non-Compliance Loop

Possible Mitigation Responses

- **Stop works** – In extreme cases – but mechanism (spill budget) available to justify re-commencement
- **Slow the dredging** operations (reduce spill budget)
- **Use of tidal windows**, reduction in production
 - Dredging / reclamation operations during flood or ebb tides
 - Dredging / reclamation operations during spring or neap tides
 - Dredging / reclamation operations during day and night time
- **Change in dredge location** (if possible)
 - Migratory, spawning / breeding seasons
- **Deploy mitigation measures** (e.g. silt screens) that are assessed (quantifiably) to address the issue



Feedback EMMP: Post - Construction

- Audit monitoring is carried out in line with baseline / control monitoring parameter to determine post-construction conditions
- Audits monitoring processing and analyses are carried out, to quantify:
 - Project objectives are met
 - net change to sensitive receptors (positive and negatives)
 - Conclude on tolerance limits, realized spill rates etc. to allow lessons learnt to be incorporated in subsequent projects



Feedback EMMP: The Take away

- The **Feedback EMMP** is a proactive adaptive management approach not just about the identification of impacts and risks; it **provides information** on the overall ecosystem during and after project implementation.
- It is **highly flexible**, allowing for changes in the project if required e.g. timing, duration of the works, etc.
- It allows for **segregation of changes/impacts** from different components of the work, from adjacent projects and from natural events
- Traditional monitoring of e.g. turbidity, sensitive habitat health and water quality are still integral, but the data collection can be **targeted at the right (and less) locations** and is used to validate and / or update the working specifications and tolerance limits and less as direct operational triggers for environmental management

Feedback EMMP: The Take away

- Because of the **level of documentation** Feedback EMMP significantly **reduce** developer (or Contractor depending on contract mechanism] environmental liability
- It allows a 'proactive' **response before unexpected deviations** or changes occur
- It allows a fully tiered response as you know **what specific aspects of the work are causing the 'problem'** and you can document that the response will be effective before you implement
- In general Feedback EMMP is **no more expensive** that traditional approaches as less sensors and less academic biological monitoring compensating for the cost of increased level of control afforded by the spill budget and hindcast controls

Thank you

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